Analysis of Dipole Antenna Printed on Thin Film by Using Electromagnetic Simulators

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Abstract: The printed dipole antenna on thin polyimide film is calculated by using WIPL-D and IE3D based on the method of moment, Micro-Stripes based on TLM method. Its input impedance characteristics are compared with measured data and discussed.

Keywords: printed antenna, method of moment, WIPL-D, FDTD method. TLM method

1. Introduction

With the development of numerical analysis method, the many kind of electromagnetic simulators are used for the analysis of antennas. Authors have calculated the dipole antenna, the linear polarized rectangular patch microstrip antenna, the circular polarized rectangular patch microstrip antenna by using the electromagnetic simulators based on the method of moment, the FDTD method and the TLM (Transmission Line Matrix) method [1]-[4]. The calculated antenna characteristics such as the input impedance, the radiation pattern, and the directivity are compared with the measured results. The features of simulators are also discussed.

Recently small antennas printed on the thin dielectric film are used for the radio frequency identification (RFID) applications [5], [6]. The FDTD method is a powerful tool for analyzing the antenna including conducting and dielectric materials. However, the numerical calculation of the antenna on thin film is time consuming, because the maximum cell size is limited to be less than about ten times of the minimum cell size in the FDTD method.

In this paper the dipole antenna printed on the polyimide film is numerically and experimentally analyzed. The input impedance of this antenna is calculated by using the electromagnetic simulators WIPL-D and IE3D based on the method of moment and Micro-Stripes based on the TLM method [7]-[9].

2. Analytical model and numerical results

Figure 1 shows the dipole antenna printed on the polyimide film. The dipole antenna of thickness 35 μm is printed on the thin film of thickness 95 μm. The antenna is covered by the film of thickness 50 μm for protection. The relative dielectric constant of film is 3.5. In this paper, following two antennas are analyzed. Antenna No.1: L=64.8 mm and d=24 mm and Antenna No.2: L=88 mm and d=38 mm.

In the numerical calculation by WIPL-D, the upper and lower films are modeled as the rectangular parallelepiped with thickness 95 μm and 50 μm, respectively. The thickness of antenna element is assumed to be infinitely thin. Figure 2 shows the geometrical model of

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Form Approved
OMB No. 0704-0188

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1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
01 JAN 2005	**N/A**	**-**

4. TITLE AND SUBTITLE	
Analysis of Dipole Antenna Printed on Thin Film by Using Electromagnetic Simulators	5a. CONTRACT NUMBER
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Dept. of Electrical & Electronic Eng., Nagasaki University 1-14 Bunkyo-machi, Nagasaki-shi, 852-8521 Japan**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES
See also ADM001846, Applied Computational Electromagnetics Society 2005 Journal, Newsletter, and Conference., The original document contains color images.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**UU**	**4**	

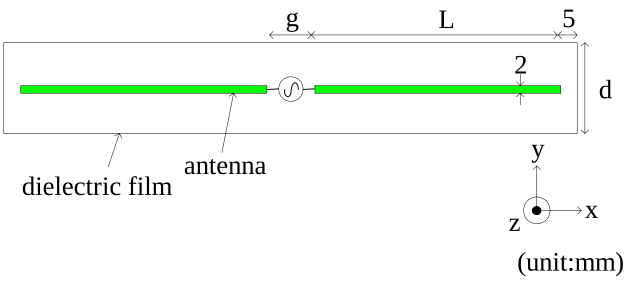
printed antenna. The total number of unknown electric and magnetic currents of Antenna No.1 are 183 and 134, respectively. Figure 3 shows the edge cell and feed wire of antenna. Two planar monopole elements are connected by the thin wire with radius of 1 μm.

In the numerical calculation by Micro-Stripes, the antenna is mounted on the ground plane in the xy plane. The antenna is located in the zx plane. The calculation region is 460 mm by 460 mm (x and y direction) by 312 mm (z direction). The minimum cell size in the calculation by Micro-Stripes is 0.25 mm in x direction, 0.015 mm in y direction and 0.8 mm in z direction. The maximum cell size is 11.5 mm in x and z direction and 11.4 mm in y direction. Figure 4 shows the calculation model in Micro-Stripes.

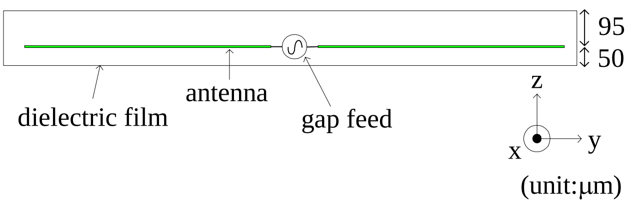
In the numerical calculation by IE3D, the infinite film is assumed. The thickness of antenna is assumed to be infinitely thin. The cell size in the highest frequency is 1/30 wavelength and the width of edge cell is 0.39 mm. Figure 5 shows the edge cell and the feed port in IE3D.

In the measurement of input impedance, the antenna is mounted on the ground plane of 1.6 m by 1.6 m.

Figure 6 and 7 shows the input impedance characteristics of Antenna No.1 and No.2, respectively. The anti-resonant frequency of the antenna No.1 calculated by IE3D is higher than that of measured data. This may be due to the fact that the width of film is narrow.

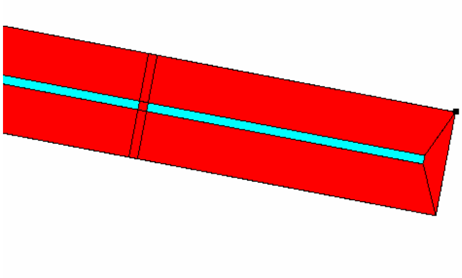


(a) top view



(b) cross sectional view

Figure 1 Dipole antenna printed on polyimide film.



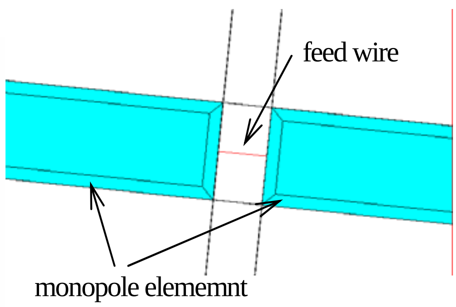


Figure 2 Geometrical model in WIPL-D.

Figure 3 Edge cell and feed wire in WIPL-D.

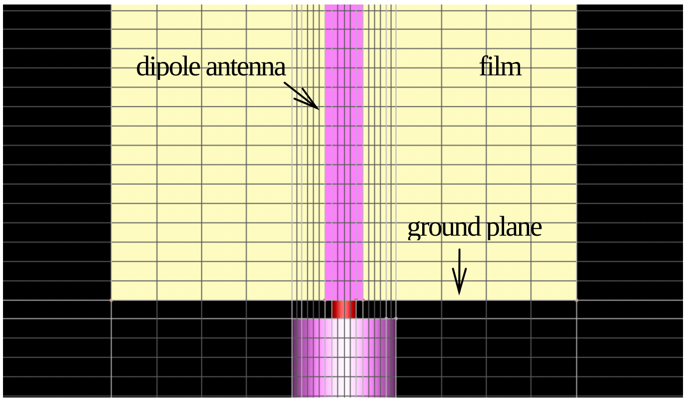


Figure 4 Modeling of antenna in Micro-Stripes

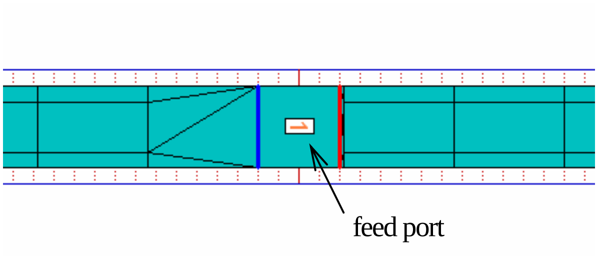


Figure 5 Edge cell and feed port in IE3D

3. Conclusion

The dipole antenna printed on the polyimide film is calculated by using WIPL-D, IE3D and Micro-Stripes. The design of small tag antenna composed of multilayer conductors on thin film for the RFID application will be presented in the next opportunity.

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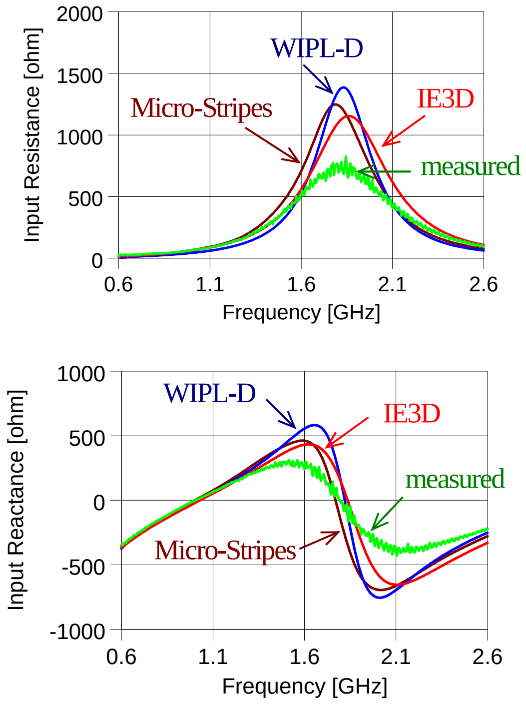

Figure 6 Input impedance of antenna No.1. L=64.8mm, d=24mm, g=2mm

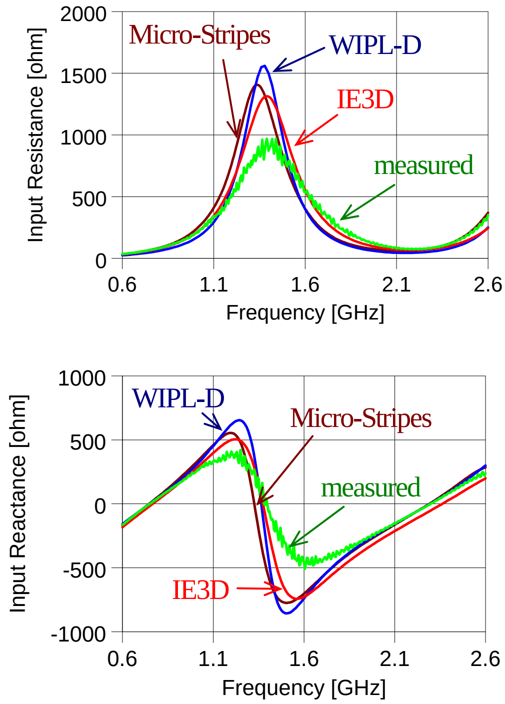

Figure 7 Input impedance of antenna No.2. L=88mm, d=38mm, g=2mm